A. M. Johnston

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WASHINGTON 25, D. C.

CN-78077

For Release Upon Delivery
12 noon
December 17, 1959

SPACE -- PAST, PRESENT, AND FUTURE

by

Dr. Homer J. Stewart
Director, Office of Program Planning and Evaluation
National Aeronautics and Space Administration

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For Presentation to the
American Ordnance Association, Washington Post
Willard Hotel, Washington, D. C.
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I am very happy to be accorded the privilege of addressing the Washington Post of the American Ordnance Association on this occasion. I have for many years followed AOA activities and know of your concern for and your efforts on behalf of the security of the United States -- not only in the special line of military defense, but also in the broader context of education, the economic well-being of the country, and international affairs.

At Christmas time, particularly, the well-being of all mankind seems to be the concern of all. In government operations, it is also a period of introspection and re-examination of policies and programs brought on by impending Congressional hearings aimed at determining in detail what our national activities should be in the new year. Accordingly, I propose to re-examine briefly the national activities in space as I see them, not only in the past and the present, but also as they reflect an image of the future.

It is obvious that the last decade has produced dramatic changes in our national viewpoints on the question of the

exploration of space. I would like to refer back, as a starting point, to a series of tests which were performed in 1949 under the sponsorship of the Army Ordnance Department under the code name, "Bumper." This project was carried out jointly by the Jet Propulsion Laboratory, the General Electric Company, and the Douglas Aircraft Company. The object of the project was to launch a Wac Corporal upper-stage vehicle from a V-2, and demonstrate a prototype high-performance, multi-stage rocket vehicle system. As you may recall, the project was entirely successful in demonstrating the feasibility of several unproved concepts: the staging of rocket vehicles at high altitudes, the utility of ablative materials for protection from aerodynamic heating, and a method of stabilizing rocket propelled vehicles operating in the vacuum of space. One of the most significant interpretations of this test to the engineers familiar with the work was the fact that the test showed that there were no longer any purely scientific barriers to the construction of vehicles capable of space flight. The barrier was engineering.

In the general atmosphere prevailing at that time, this most significant result could not be announced from the house tops. Indeed, public discussion of space activities was considered at that time to be in rather poor taste. It was only within the privacy of some scientific and engineering institutions, such as Rand or the Jet Propulsion Laboratory, that the significance of space was dimly recognized. I say "dimly," even though JPL, working for the Navy, and Rand, for the Air Force, had already made studies of satellite problems.

Within the United States the first definite step toward the active exploration of space occurred in the summer of 1955 when the President announced that we would, as part of our participation in the International Geophysical Year activity, attempt to launch at least one scientifically instrumented satellite into an orbit around the earth during the 1957-1958 period. In our planning to carry out this commitment we decided to do the work on the smallest significant scale, more as a demonstration of the feasibility of space activities than as a real beginning of the exploration of space.

The next critical step in inaugurating a national program for the exploration of space came three years later with the passage of the National Aeronautics and Space Act of 1958. The Act established the National Aeronautics and Space Administration and, as a matter of national policy, directed NASA to "plan, direct, and conduct" such "activities as may be required for the exploration of space." It is this instruction to carry out the exploration of space which is the unique feature of the charter of NASA, and it is this responsibility which requires NASA to make significant contributions over the long term to the security of the nation -- in a new way.

The long-term security of our country requires that we retain the climate of intellectual vigor and vitality, which in the past has been such an important element of our national strength -- a factor that has produced and has attracted the

best efforts of mankind everywhere. The dimly felt but undeniably important long-term results of the exploration of space must be expected to affect strongly the intellectual life of all mankind, and we in the United States must play a responsible role in exploring this new frontier for the benefit of humanity.

We have by now carried out a number of experiments which have clearly demonstrated the feasibility of operations in space. Our scientific results from these experiments have convinced us that space is an intellectually fruitful environment for scientific experiment. For example, Explorer I, whose successful launching in January 1958 formally fulfilled our national commitment to the IGY, demonstrated that our understanding of the outer reaches of the earth's atmosphere was far from correct. As a consequence, many of our later flights have been instrumented to explore in greater detail the great radiation belts surrounding the Earth. We have also taken our first step beyond the gravitational field of the Earth with our Pioneer IV space probe, launched last March and now in orbit about the sun.

While we have had many successes and have produced much significant scientific information, our activities have not been fully satisfying because our scale of activity is small and limited in comparison with that of our only competitor, the USSR. The Soviet space exploration program, presumably, was formally organized in 1954 when their Interdepartmental

Commission for Interplanetary Communication was established -- four years before NASA was created. It is now evident that their initial planning called for an aggressive space program so that highly significant exploratory experiments could be boosted into space. In effect, they bypassed completely the small-scale feasibility demonstration -- the Vanguard phase -- which was our initial step.

At the present time our program for the exploration of space has two principal features: (1) using interim capabilities created on a short-term basis for the limited uses they permit, (2) preparation of more versatile and powerful equipments to carry us into a sound program for the long haul. Both of these activities are essential. For example, if we were to refrain from using the interim vehicles and only concentrate our entire effort on long-term preparation for the future, not only would our position in the international arena be more greatly jeopardized, but, technically, we would have probably missed some of the scientific factors which may well be of great significance in guiding the course of our future activities. On the other hand, if we were to concentrate our entire attention on the exploitation of our present limited capacities with no effort spent on preparing more efficient and more capable equipment for the future, we would be placed in an even less defensible position. Maintaining a proper balance between these two activities is consequently one of our most serious problems.

In order to serve our interim needs for space vehicles, we are using the upper-stage rockets developed under the Vanguard and Jupiter C programs. Thus our initial venture into space is dependent on these smaller rockets and the larger IRBM booster rockets developed as part of our military effort. For example, we have combined the spinning cluster of solid propellant rockets used on Explorer I with the Jupiter IRBM to create what we now call the Juno II vehicle. The upper stages of the Vanguard have been combined with the Thor IRBM to create the Thor-Able and the Thor-Delta vehicles.

The largest scientific payloads we have up to this date placed in orbit are the 90-pound Explorer VII payload, launched by a Juno II, and the 142-pound Explorer VI payload launched by a Thor-Able. Somewhat larger payloads have been launched in the Discoverer series; however, these somewhat larger payloads are possible only in very low-perigee, short-lived orbits which are not well suited for most space science experiments.

One way to compare the effectiveness of these interim configurations with more appropriately designed equipment is to note the ratio of takeoff weight to payload weight. For the 142-pound Explorer VI, the ratio is about 750 to 1. A properly proportioned three-stage vehicle using our current level of technology, the same as that used in any of our large military vehicles, would have takeoff weight to payload weight ratio of 40 or 50 to 1; that is, our present exploitation of the booster

vehicle in satellite orbits is less than 10% effective. Similarly, the Pioneer IV had a net payload weight of only 12 pounds for a ratio of about 8000 to 1. Again, a properly proportioned vehicle would produce a ratio of about 150 or 200 to 1, and our efficiency of exploitation, in this case, is thus less than 3%.

These ratios show clearly that our present operations are not primarily limited by the size of our first-stage booster rockets -- even though in the long run we require substantially larger booster rockets. Our present primary limitation lies in the fact that we do not have the appropriately scaled upper-stage rockets to exploit efficiently our large military booster rockets as first-stage launching vehicles.

We are now developing the Agena and the Centaur upper-stage rockets to permit an efficient exploitation of our IRBM and ICBM boosters. For comparison it may be of interest to note that the high-energy propellant development used in Centaur is expected to produce a payload capacity in an orbit corresponding to a ratio of takeoff weight to payload weight of about 30 to 1, twenty-five times as effective an exploitation as our best effort to date.

We are also proceeding with the development of the Saturn booster which is roughly four times the size of the Atlas ICBM. Part of the Saturn project envisions the use of upper-stage rockets to exploit efficiently this very large booster capacity. Still longer-term and higher-performance vehicles are required for later space exploration missions. A first step toward

satisfying this future requirement is the development of a one-and-a-half million pound thrust single chamber rocket engine which can be clustered to power the very large vehicles which we foresee for the future.

Until we have the upper-stage developments to permit us to use our present booster capacity effectively we will not be able to carry out the more significant space exploration missions which require precision guidance and substantial payloads. It is also quite apparent that until these new equipments are available the cost per pound of payload in orbit will be inordinately high. It is necessary for us to go to great lengths in miniaturization of equipment in order to maximize the effectiveness of our overall operation.

Even with these limitations we expect our flight program in this interim period, which will cover all of the next year, to produce significant and important results. We will continue our exploration of the nature of the great radiation belt and of the ultraviolet and gamma radiation outside the Earth's atmosphere. We expect to make further measurements of the infrared radiation characteristics of the Earth and related measurements of significance to the meteorological forecasting problem. We expect to make some communications experiments using a large 100-foot sphere as a passive reflector for radio transmissions. We also expect to be well down the road on the final phases of preparation for Project Mercury. The capsule

check-out should be nearly completed and the Astronauts should have entered the most advanced phase of their training with the suborbital Redstone flights. It is perhaps of interest at this point to note that Project Mercury requires only a relatively low-perigee, short-lived orbit. Consequently, we do not have to wait for the development of more capable equipment; the standard Atlas vehicle is capable of producing the required performance.

In summary, we are carrying out a flight program which has yielded, and will continue to yield, interesting and significant results, even though we are still severely limited by the interim nature of our flight vehicles. We have underway the new vehicle developments which we expect will increase greatly our efficiency of operation and our capability to operate in space. The rate at which we will progress into the exploration of space is of course dependent upon the resources which are placed at our disposal; however, I can assure you that we at NASA are making every effort to make certain that these resources are efficiently used so as to produce the most effective over-all program.

Thank you and Seasons Greetings!

NASA Release No. 59-280